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STRATEGIES TO IMPROVE BALI CATTLE IN EASTERN INDONESIA

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Management to Facilitate Genetic Improvement of Bali Cattle in Eastern Indonesia

Geoffry Fordyce[1], Tanda Panjaitan[2], Muzani[2] and Dennis Poppi[3]

Abstract

This paper emphasises the importance of developing a genetic improvement program that is not isolated from the social and physical environment in which it is operating. Growth and reproduction are likely to be the most important genetic traits. The minimum requirements to select for them are clear and permanent identification of animals together with records of pedigrees, weights, diet, husbandry, breeding dates and breeding outcomes. Nutrition needs to be improved and standardised to accelerate breeding by reducing the age of puberty and the post-partum anoestrous interval. Artificial breeding is useful but is not essential and, in many Bali cattle breeding systems, may be less efficient than well-controlled natural mating. The key appears to be to minimise costs and inconvenience, and this means substantial modification of the high-input systems used in many 'Western' countries. Possible strategies for doing this in Indonesia are outlined in the paper.

Introduction

BALI cattle (*Bos sondaicus*) are small (~⅔ Brahman size) and have the combined physical and behavioural traits of other cattle, buffalo, and deer. They have the same number of chromosomes as cattle (n = 60), though F1 male crossbreeds with *Bos indicus* are infertile (Kirby 1979). Herd dynamics of current production systems for Bali cattle in eastern Indonesia indicate that most weaner heifers are required as replacement breeding cows, but that 40% of females from a village group are sold annually. This level of sales is unsustainable and accounts for the decline in stock numbers. Strategic management that increases the annual proportion of cows rearing a calf from 65% to 80%, and which decreases calf mortality from 15% to 10% should enable:

- net turnoff to increase by a third, with annual turnoff of about 50% of females possible;
- farmers to sell annually about 25% of weaner heifers.

The cattle industries of the world have a long history of attempts to improve production efficiency by changing the genotype — the 'magic wand'; but the frequency of success is usually quite low. McCool (1992) suggested that replacing indigenous with exotic breeds in South East Asia might in fact create significant problems, e.g.:

- dystocia because of heterosis increasing calf birth weight;
- low tolerance of diseases, parasites, poor nutrition, and harsh environmental conditions;
- increased work to feed each animal because of higher growth and greater size at maturity.

Genotypes that might be used in crossbreeding or breed replacement are typically 50% larger than Bali cattle. If the feed provided does not increase to match increased requirements, most of the diet will be expended on maintenance and very little on production, with the consequence of very low productivity.

Bali cattle appear suited to the needs of the farmers of eastern Indonesia. Significant opportunities exist to improve them through selection. However, to achieve genetic improvement the industry must have systems that:

- identify and use elite breeding (seed) stock;
- enable dissemination and use of these seed stock by smallholders.

The management requirements to efficiently support this are discussed in this paper.

[1] Department of Primary Industries, PO Box 976, Charters Towers, Queensland 4820, Australia
[2] BPTP, J1 Raya Peninjuan Narmada, PO Box 1017, Mataram, Indonesia
[3] School of Land and Food Sciences, University of Queensland, St Lucia, Queensland 4072, Australia

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Identifying Suitable Breeding Stock

For any level of success in genetic improvement, breeding objectives must be established. Initially, the ideal characteristics of the cattle are defined. These may include being of a size that enables them to be fed properly each day, as well as being fertile and of good temperament and having a high growth rate. The relative importance of each of these characteristics (traits) is then determined so that correct emphasis can be placed on them during selection. That importance is determined by its economic impact, whether it is heritable, and if it can be measured. Selected animals (G1) of a seed stock producer may product progeny (G2) within one year. G2 progeny might be raised, sold, and mated to produce their first progeny (G3) at three years of age. G3 animals may then be sold for breeding or slaughter at two years of age. Therefore, the importance of traits needs to be judged in the light of the expected financial, social, and physical environment many years hence. In either an elite breeding program or a commercial smallholder situation, bulls — and to a lesser extent females — are then selected so that when mated, they will produce progeny which have the desired traits in the required balance.

Identifying superior animals requires management that enables fair performance comparisons to be made between individuals. Direct comparison of contemporaries requires rearing on similar diets and husbandry systems in the same environment. This process is significantly enhanced when records are kept to enable objective comparison and correction for management differences. In the initial stages of a genetic improvement program where no records are available, some form of subjective assessment is required to identify those animals most likely to have the best phenotype.

Growth and reproduction are likely to be the most important traits to be used in selecting breeding cattle. To record the data requires unambiguous, secure, individual identification attached to each animal. Basic records required include:

- pedigree and dates of key life events such as birth, weaning, mating;
- weight and/or body condition at critical points such as birth, weaning, seasonal interfaces and sale, using a consistent weighing protocol;
- information on diet and husbandry for different management groups;
- time of puberty if known and reproductive events in each year.

Records can be kept in book systems that enable simple assessment and easy access and analysis for any person involved in the program. Information must also be in a format enabling easy transfer to computer systems for more detailed analyses. Such records are being maintained in a current ACIAR-sponsored demonstration (Project ACIAR.AS2.2000.103) of efficient cattle management in Lombok and Sumbawa.

Mating

Cattle control

The fundamental requirement of genetic improvement is animal control so that each female is mated to a selected bull. Most Indonesian cattle owners will use natural mating, thus requiring ready access to the desired bull through the mating period. Systems can be established to allow mating of oestrous females while denying access by other bulls. The ACIAR demonstration cited above is using a mating pen or area into which oestrous females are introduced during the desired mating season; this is proving very successful and has high farmer acceptance.

Female cyclicity

Mating will occur only when the female is in oestrus. Management based on a good understanding of reproductive performance is required to maximise the chance of mating during the optimal period. Reproductive traits of Bali cattle established from Indonesian, Australian and Malaysian studies have been reviewed by McCool (1992) and Wirdahayati (1994). Key features from these reviews and from unpublished information include:

- Puberty is generally reached by both males and females between 12 and 24 months of age, at weights from 100–150 kg.
- There is no real evidence of a significant photoperiod effect on cyclicity.
- The average length of the oestrus cycle is 21 days, with some evidence that it is shorter when nutrition is poorer.
- Oestrus is primarily a nocturnal event, with an average duration of 18–19 hours.
- Pregnancy occurs after an average of two matings. This may be due partly to the widespread use of artificial breeding, but it does suggest embryonic mortality rates of at least 30%, which is normal for cattle in the tropics (Holroyd et al. 1993).
- Pregnancy rates in cyclic females are high.
- Gestation is between 280 and 290 days.
- Calf birth weight averages about 17 kg, but may be less than 9 kg in poorly nourished cows.
- Calf mortality rates vary between 2% and 40%. Higher levels occur in small calves and if management does not support mothering.

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- Calving to conception intervals typically average around five months, indicating a significant post-partum anoestrus problem.

The above performance parameters indicate substantial opportunity to improve both the chances of cycling during the optimum period, and the ability to successfully raise calves. Nutrition is the primary limiting factor, since dietary quality of cattle in the tropics is very seasonal. Good management capitalises on the ability of cattle to efficiently store energy (muscle and fat) during periods of adequate nutrition to enable survival and continued production through seasonal periods of poor nutrition. Improving nutrition via supplements increases utilisation of available poor quality forages and provides additional nutrients directly.

Improving nutrition of breeding females will:

- advance age at puberty, and may also decrease weight at puberty (Fordyce 1998). Early puberty increases lifetime reproductive efficiency (Fordyce et al. 1994);
- increase calf birth weight. Fordyce et al. (1993) reported a variation in calf weight of 25% due to variations in late-gestation nutrition of *Bos indicus* × *Bos taurus* cattle. Late-gestation supplementation of Bali cattle can substantially increase calf birth weights (a component of 'flushing') (unpublished data);
- increase milk yields, and hence calf growth (Fordyce et al. 1996), This is an objective of 'flushing' of Bali cattle, which includes energy supplementation in the two months post-partum, reputedly resulting in much lower calf mortality rates;
- reduce the post-partum anoestrus interval (PPAI). Fordyce et al. (1997) showed that short-term (50 days) pre-calving energy supplementation (equivalent to the pre-partum component of 'flushing') can significantly reduce the PPAI. Post-partum supplementation to reduce the PPAI tends to be far less effective and more expensive because much of the elevated energy intake is diverted to milk production.

Nutritional management strategies include:

- ensuring that appetite is satisfied in both cut and carry and grazing systems, and that cattle have ready access to plentiful clean water. The small mature size of Bali cattle is a distinct advantage in a cut and carry system;
- through seasonal mating, synchronising lactation with high-nutrition periods. The physiological effects of late pregnancy and lactation typically increase maintenance demands for nutrients by up to 50% (Fahey et al. 2000). Hence, in many tropical regions, restricted mating is used to prevent lactation of cows during periods of poorest nutrition.

  Mating is often timed so that calving begins just before rain is expected. In these systems, mating duration is no longer than seven months, so if all suckling calves are weaned at the end of a seven-month mating, lactation is prevented in all cows for at least two months.

  Mating periods can be reduced to as low as three months if nutrition and management are very good. However, Fordyce (1992) reported that weaning rates might be lowered by as much as 20% where nutrition is not optimal, so a minimum mating period of five months is recommended under such conditions. In practice, when implementing restricted mating systems, a seven month mating period should be used in the first year and thereafter reduced in response to conception patterns and weaning rates.

  Kirby (1979) reported that changing the mating period of Bali cattle to synchronise lactation with periods of high pasture growth did not diminish their fertility. In the ACIAR demonstration we have had very high pregnancy rates early in our defined mating period of five months, though the specific period varies according to climate and draught requirements of cattle;
- weaning practices that aim to minimise lactation during periods of poorest nutrition. Weaning at the appropriate time is an integral component of sustaining high herd reproductive rates by maintaining cows in relatively high body condition (Fordyce 1992), thus ensuring that ovarian function and follicle growth are not compromised. In the ACIAR demonstration, we are observing the effect of weaning and how it can be done in village systems;
- strategic provision of supplements containing key limiting nutrients when high responses are expected — e.g. protein meals or high-protein forages such as leucaena leaf in the dry season to animals with ad libertum access to roughage. More specifically in the ACIAR demonstration, we are 'flushing' cows during the dry season by supplementing those that will calve or have calved within two months. The objectives are to enhance ovarian function, increase birth weight and raise milk yields;
- limiting the effect of stress factors that significantly depress intake or increase energy expenditure. Strategies include control of ecto- and endo-parasites (e.g. fluke) and strategic use of animals for draught or other purposes requiring significant energy expenditure.

Nutritional management strategies that reduce age at puberty and the PPAI will reduce generation interval and accelerate genetic progress. Fertility can be enhanced by selection and is repeatable (Fordyce et al. 1988), so retention of females that exhibit high reproductive performance early in life will elevate lifetime fertility of a female group. If research with other cattle species (Toelle and Robison 1985; Davis 1992) can be extended to Bali cattle, then bulls with larger scrotal size may sire female progeny that reach puberty earlier.

Bull fertility

Fertile matings in *Bos indicus* (presumably similar to the situation in Bali cattle), require 2–10 million normal sperm per ejaculate (Den Daas et al. 1998). Typical Bali bulls produce 2.6×10^9 sperm per day (McCool 1992) and even with only 50% normal sperm produce at least one million such sperm per minute, i.e. a potentially fertile ejaculate every 10 minutes. Therefore if a bull is reproductively sound, which most appear to be (Wirdahayati 1994), mating capacity is limited only by libido and opportunity. As in most production systems where an excess of bulls is used, individual fertile bulls may easily impregnate at least 50 females during a short mating period each year (Fordyce et al. 2002).

The breeding soundness of selected bulls should be assessed prior to mating, particularly where single-sire mating is used. This is the practice within the ACIAR demonstration programs. Holroyd et al. (2002) have outlined the key attributes to secure a high probability of fertile bulls; it is particularly important that they have at least 50% normal sperm in an ejaculate (Fitzpatrick et al. 2002).

Artificial breeding (AB)

AB is used throughout the world's beef industries, mainly to produce genetically superior breeding animals which are then disseminated and mated naturally in commercial production systems. The cost per calf of AB is usually much higher than for natural breeding; for example in northern Australian herds it typically exceeds A$50, vs. A$5–20 when natural mating is used. In cattle production systems where group sizes are small, as in Indonesia, access to bulls may be as difficult as or more difficult than access to AB. This may bring the real cost of service closer for the two systems. However, unless AB provides higher value genetic material than that available through natural service, natural mating will be the most efficient system in most situations. Artificial breeding is used for more than 70% of cows on Lombok and 30% of cows on Sumbawa, apparently to improve the genetics of the herd and to overcome a shortage of bulls.

In a typical northern Australian beef herd, conception rates to natural mating average about 70–75% per cycle, due to embryonic mortality levels of 25–30% (Holroyd et al. 1993). This results in an average of about 1.5 cycles per conception. In contrast, conception rates per cycle using AB are in the vicinity of 50% per cycle, even with the best technology available (Boothby, personal communication) and are much lower when AB systems are not ideal. This results in a minimum of 2 cycles per pregnancy and may therefore contribute to low herd fertility.

Other major limitations to successful artificial breeding (*Project In Calf:* a current national Australian dairy program) that are very relevant in Indonesia include:

- oestrous detection. This is more a problem when the predominance of expression is at night, as is the case for Bali cattle;
- access to semen and AB technicians, particularly where there are problems of communications and access;
- the skills and experience of AB technicians.

In the ACIAR demonstration, we are using only natural mating in commercial village systems, to avoid the inefficiencies of AB and to take full advantage of efficient, natural, controlled mating with bulls that meet breeding objectives. However, it is clearly recognised that AB is a valuable tool for introducing elite genetic material.

Integration of Requirements into Effective Management for Smallholders

Management systems

For smallholders, low-input, low-technology management systems must be used because of limited resources and capital investment. The efficiency of any beef cattle production enterprise is as in Figure 1:

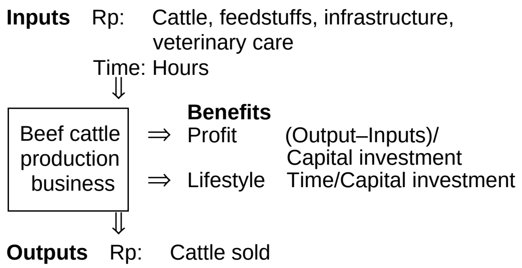

Figure 1. Efficiency of a beef cattle production enterprise.

McCool (1992) recognised that high-input 'Western' systems are inappropriate for many Asian situations, but indicated that relatively low-cost and

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targeted (strategic) management might substantially improve production efficiency. The efficacy of such systems has been demonstrated by Fordyce (1998), who reported an average weaning rate of 83% for a *Bos indicus* × *Bos taurus* herd using very low but strategic inputs in the dry tropics. In the ACIAR demonstration, we have introduced low-cost modifications to management including seasonal mating, use of selected bulls in natural mating enclosures, dry season weaning, strategic dry season supplements for pre-pubertal heifers and breeding cows, individual animal identification, and data recording. These modifications are designed to ensure that business objectives are met by increasing pregnancy rates in lactating cows, reducing calf mortality, reducing the bull cost per calf, and increasing average postweaning growth rates and survival. This will minimise costs, increase turnoff rates, reduce average turnoff age, and increase net financial returns. To date, villagers using these strategies are very pleased, as they perceive improved financial efficiency with little extra input, and without losing opportunities to use animals for draught.

Stud industry sector

A feature of any animal industry with a record of successful genetic improvement is a nucleus elite animal breeding industry that is operated commercially. In western cattle industries, this is referred to as the stud sector. Such a sector currently does not appear to exist in eastern Indonesia. To successfully establish a stud Bali cattle industry to enhance genetic progress, the industry will need to establish reward for bull ownership through such avenues as service fees, semen sales, and premiums when bulls are sold for breeding.

Individual villages will select bulls to meet their breeding objectives using whatever information they can gather on available stock. However, the existence of a nucleus industry which can produce breeding stock that meet their objectives should dramatically improve genetic progress.

To encourage reward for ownership of bulls and elite females we are introducing, in two of the villages, competitions linked to the ACIAR demonstration. Cattle will be judged on traits such as weight corrected for age, breed character, calf output and temperament, while bulls will be judged on breeding soundness examination results. This activity will:

- encourage good animal management, data recording, and use of Bali cattle;
- underpin future genetic improvement programs. It is likely to show that the genes for large Bali cattle still exist.

Managers

Success in adopting new cattle management and breeding systems in eastern Indonesia will rely on developing the appropriate knowledge, skills and experience in cattle breeding by cattle owners. This must be done by providing technical training in a range of forms to cater for different ages and cultures of producers. In all cases, for successful adoption of the new methods cattle owners will have to:

- see the need and opportunity to change;
- recognise that better management strategies are available;
- be exposed to low risk in adopting new methods;
- be supported by readily available technical and advisory services.

A switch to new methods is a slow and different process, as major changes to traditional thinking are needed. In project ACIAR.AS2.2000.103, we are initiating extension of the demonstrated cattle management strategies. We are using proven methods of achieving change, and these focus on the perceived needs of the cattle owners. At this early stage of the project, however, we do not have any significant progress to report.

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